Advisory Committee on Energy Efficiency

Energy efficiency standards for improving and optimising the energy consumption of electric driven machine units

The webinar will start in a few minutes...

November 22nd, 2021
Philippe Vollet, Maarten van Werkhoven & Conrad U. Brunner
IEC Academy Webinar on ACEE and CAISEMS
Advisory Committee on Energy Efficiency

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Information

Please use the Q&A function for questions.

All questions will be answered after the webinar and uploaded as Q&A to www.iec.ch/academy.

Slides, Q&A and recording will be available after the webinar at www.iec.ch/academy.
Speakers

Philippe Vollet
IEC ACEE Chairman – IEC SC23K Secretary
He has been working for Schneider Electric since 1989, at several positions from Engineering, Business Development, Offer management and Strategy for both Low and Medium Voltage divisions. He has been involved in standards work since 2013, mainly in Energy Efficiency and Smart Building topics.

Maarten van Werkhoven
Independent consultant on energy efficiency, research and technology in industry and commerce. Acting as Operating Agent of the IEA Technical Cooperation Program 4E Electric Motor Systems Annex EMSA. Maarten is member of IEC ACEE, convenor of Task Group 6, and member of JAG22.

Conrad U. Brunner
Independent energy efficiency consultant, based in Switzerland. Main area of research, consultancy and advice in electric efficiency in industrial machines, like motors, variable frequency converters, and also pumps and fans. Member of IEC ACEE and JAG22, and of ISO TC 115 for pumps and ISO TC 117 for fans. Focus is to have the know-how of mechanical and electrical engineering combined in order to build and operate energy efficient electric machines.
IEC ACEE
Energy efficiency standards for improving and optimising the energy consumption of electric driven machine units

Agenda

✓ IEC ACEE: Introduction
   Philippe Vollet
✓ IEC ACEE TG6: Project CAISEMS
   Maarten van Werkhoven
✓ IEC ACEE TG6: Efficient motor systems: when IEC and ISO collaborate
   Conrad U. Brunner
IEC ACEE
Introduction

Presentation

Philippe Vollet
ACEE Chair
ACEE – ID Card

✓ ACEE deals with energy efficiency matters which are not specific to one single technical committee of the IEC.
✓ ACEE provides guidance for implementation.
✓ It encourages a systems perspective.

(Extracts)

✓ 8 Members nominated by NCs: CA, CH, CN, IT, JP, KR, NL, US
✓ 8 Members nominated by Entities: TC 9, TC 14, TC 23, TC 27, TC 64, TC 66, TC85, TC 121
✓ 1 Internal IEC Liaison: IECEE
ACEE – ID Card

✓ IEC Guide 118:2017 - Inclusion of energy efficiency aspects in electrotechnical publications:

   Guidance on how to consider energy efficiency aspects when preparing IEC publications

✓ IEC Guide 119:2017 - Preparation of energy efficiency publications and the use of basic energy efficiency publications and group energy efficiency publications:

   Procedures for the preparation of energy efficiency (EE) publications
   Relationship between technical committees (TCs) with group EE functions.

✓ Energy Efficiency Functions (SMB/6523A/RV & SMB/6791A/RV)

   TC64: Guidelines for energy efficiency of low-voltage electrical installation.

   SC 22G: in the context of the development of IEC 61800-9-1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytical model (SAM)
IEC Advisory Committee on Energy Efficiency
Definition of energy efficiency (IEC ACEE Guide 118)

Ratio: **output of performance** vs. **input of energy**

- **Same performance**
  - Less energy used
  - Same energy use

- **Better performance**
  - Less waste
  - More usable energy
ACEE- IEC Academy Webinars

✓ Webinar 1: June 23, 2020
  ➢ ACEE - Energy Efficiency
    Key Principles, terminology and good practice for use in electrotechnical publications

✓ Webinar 2: September 22, 2020
  ➢ ACEE - Energy Efficiency
    Case study on low-voltage electrical installations
  ➢ Case study on electric motors

➢ Webinar 3: November 22, 2021
  ➢ Project CAISEMS
  ➢ Efficient motor systems: when IEC and ISO collaborate

Please, to know more: feel free to:
  ➢ to download the previous webinars on the IEC academy webpages
  ➢ to visit our ACEE webpages
IEC ACEE
Project CAISEEMS

Presentation

Maarten van Werkhoven
IEC ACEE member
Global electricity end-use ➤ Motors and Appliances

ELECTRIC MOTOR DRIVEN SYSTEMS (53 %)

Global end-use electricity: IEA WEO 2016
Electric motors

Electric motors drive
• pumps
• fans
• compressors
• transport systems
• handling & process systems
• others

Motors are responsible for 53% of global electricity use
• Industry: share 60-70%

IEA World Energy Outlook 2016
System standards - energy efficiency
Standardization bodies

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Energy efficiency standards:
- definition of scope
- testing standards
- efficiency classification
Complexity of EMDS (constant and variable load)

- Cooperation: planning, assembly, testing, operation
- System optimization has big advantages:
  - Lighter, smaller, cheaper
  - High reliability
  - Less waste heat → more energy efficient
  - Lower peak load (kW)
  - Lower electricity consumption (kWh) and cost (EUR)
  - Improved controls: Start/Stop; peak and part load; hours of operation
Background

- IEC ACEE: systems considerations for EMDS (2018/19)
- Workshop Sept. 2019 – start of CAISEMS
IEC ACEE (Advisory Committee on Energy Efficiency), Task Group 6

- CAISEMS: coordination and alignment of standards for energy efficient electric motor driven systems
- Goal: cooperation between IEC and ISO, provide a platform to facilitate coordination and alignment
- 1st meeting 20 September 2019 in Tokyo, Japan
  - 25 participants
- 6th meeting: 20 September 2021, teleconference
CAISEMS Goals

- solid overview of existing IEC and ISO standards for energy efficiency of EMDS
- platform for systems: "wire-to-water / air"
- system calculation of efficiency/losses (ex ante):
  COMPONENTS ➤ SYSTEM
- interface:
  MOTOR SYSTEM ➤ DRIVEN SYSTEM
- system acceptance test (ex post)
- calculation allows any operating point

CAISEMS Benefits

- Facilitating systems optimization through transparency between standards, referencing
- *exchange of information* among IEC and ISO TCs to explore relevant opportunities for coherence, convergence and complementarity
- avoid duplication, unnecessary redundancy or diverging and conflicting elements ➤ ensuring the “interoperability” of the different standards falling into EMDS boundaries
- Each ISO and IEC product TC may have different energy metrics for its product, but all these metrics should find a general combined applicability when it comes to specifying system performance
Example: Fan system power losses
(Source: ISO 12759-2, 2019)

Test, Calculate - Ex Ante
Test, Calculate - Ex Post

Key
1 control
2 motor
3 transmission
4 fan

Wire
Water
Air

on-site assembly

---
a Input power.
b Control losses.
c Motor losses.
d Transmission losses.
e Fan losses.
f Fan air power.
Work CAISEMS, 2019-2021

- CAISEMS: 60 members (contributing actively / monitoring)
- Liaisons and cooperation with IEC and ISO TCs
- Background Document 2020 (overview of Standards, Scope, Metrics, Operating Points, MEPS-requirements) (see www.IEC.ch/ACEE)
- 2021 -> preparing for start of a formal ISO & IEC Joint Entity, by 3 founding IEC and ISO TCs:
  - IEC TC 2: motors
  - IEC TC 22/SC22G: VFDs/power drive systems
  - ISO TC 117: fans
- Formal kick off on 19 October 2021
Optimized Energy and Power Consumption of Electric Driven Machine Units [e.g. pump, fan, compressor]

*Calculation and measurement of energy losses in electro-mechanical systems*

- To facilitate the exchange and coordination between ISO and IEC in the field of all types of Electric Driven Machine Units (EDMU).
- To identify the relevant coordination issues and proposed solutions and describe these considerations or results of such exchange and coordination discussions for guidance, reference.
- If the committees involved identify the need for producing a document, this can get the format of a Technical Report.

The JAG is a joint IEC and ISO advisory group (JAG) involving IEC SC 22G (converters, secretariat), IEC TC 2 (motors) and ISO TC 117 (fans). ISO TC 115 (pumps) and ISO TC 118 (compressors) are invited to participate, as well as any other interested ISO and IEC committee. Members are nominated experts from the concerning NCs and up to two members delegated by each of the concerning committees.
### SC 22G Adjustable speed electric power drive systems (PDS)

#### SC 22G Subcommittee(s) and/or Working Group(s)

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<td>Optimized Energy and Power Consumption of Electric Driven Machine Units [e.g. pump, fan, compressor]</td>
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Take aways

• Efficient Electric Motor Systems can contribute substantially to climate goals
• Internationally coordinated standards make it easier for national governments to establish minimum requirements for efficient products
• Making the step from product to system makes this an even more important prerequisite
• IEC (electric) and ISO (mechanical) Standard Committees need to interact more closely, to deal with energy efficiency in Electric Motor Driven Systems in a timely fashion
IEC ACEE

Coordination Example
TC2 & TC117

Presentation

Conrad U. Brunner
IEC ACEE member
Thank you for your attention!

Any Questions and/or Remarks?
Thank you!
Efficient motor systems: when IEC and ISO collaborate

IEC ACADEMY
22 November 2021

Conrad U. Brunner
Switzerland
This means for industrial motor systems:

1. Reduce to necessary demand: pressure and flow, capacity, temperature, etc.
2. Downsize all components to actual demand.
3. Use only when necessary.
4. Load control is imperative.
5. Go to direct-drive wherever possible.
Fan with V-Belt, big motor, no load control
https://www.engineerlive.com/content/industrial-pump-survival-guide-beginners
AIR-COMPRESSOR

Zhengzhou Kaishan
JN Series Energy-Saving Two-Stage Screw Air Compressor
BBC IE0, before 1988
(fresh paint only)
VARIABLE FREQUENCY CONVERTER

Danfoss VFC with screw compressor
THE #1 CASE

The outset

• Any 10 kW nominal output machine,
• could be a pump, a fan, or anything that rotates.

• The machine at the outset:
  Oversized, with fixed speed, with gear and V-belt, current market components.

• the system improved:
  Downsized, with adjustable speed, direct drive, efficient components, operated only when needed.
OLD SYSTEM

Efficiency: OLD SYSTEM

Energy demand and cost: OLD SYSTEM

Energy demand and cost: OLD SYSTEM

VFC Motor Gear Belt Pump Total

Efficiency:

- VFC: 90%
- Motor: 52%
- Gear: 0%
- Belt: 10%
- Pump: 20%
- Total: 100%

Energy demand and cost:

- kWh/a: 89'062
- EUR: 133'593
ONLY NEW MOTOR

Efficiency: NEW MOTOR

Energy demand and cost: NEW MOTOR

Energy demand and cost:
- VFC: 95%
- Motor: 55%
- Gear: 0%
- Belt: 10%
- Pump: 20%
- Total: 63'741 kWh/a
- Cost 10 years: 95'612 EUR
THE NEW SYSTEM

- coordinated components
- 5 kW motor instead of 10 kW
- 3500 h/a of operation instead of 4500 h/a
- 74 % total system efficiency instead of 52 %
POSSIBLE ENERGY SAVINGS

**Efficiency: OLD SYSTEM**

- VFC: 90%
- Motor: 80%
- Gear: 70%
- Belt: 60%
- Pump: 50%
- Total: 52%

**Efficiency: NEW SYSTEM**

- VFC: 98%
- Motor: 88%
- Gear: 78%
- Belt: 68%
- Pump: 58%
- Total: 74%

**Energy demand and cost: OLD SYSTEM**

- Energy: 89'062 kWh/a
- Cost 10 years: 133'593 EUR

**Energy demand and cost: NEW SYSTEM**

- Energy: 15'917 kWh/a
- Cost 10 years: 23'875 EUR

**Savings 82%**
THE #1 CASE

What we have learned

• electric energy savings: up to 82%
• energy cost savings: up to EUR 109'000 in 10 years

What you need to buy:

• a new 5 kW IE4 motor EUR 1'000
• a new 5 kW IE3 VFC EUR 1'000
• a new 5 kW pump/fan EUR 2'000
• get it installed and adapted* EUR 4'000

► that is only around ONE YEAR PAYBACK

Conclusion: money is often NOT the barrier!

*) 2 mechanics in four days: 32*100 EUR
The new system means:

1. Supply meets demand: no more oversizing
2. Time of use: run only when needed (night, weekend)
3. No standby losses
4. Motor connects to pump/fan directly:
   - Direct drive, no gear and belt necessary
5. Load control at any time is necessary: VFC
6. Use high efficient components:
   - Motors: IE4
   - VFC: IE2 or IE3
   - BAT for pumps and fans
Example IEC & ISO cooperation

Update IEC and ISO

New Interpolation Method
IEC TS 60034-31

IEC TC 2, WG31:
IEC TS 60034-31, ed.2
Application Guide
Annex D
Interpolation method

ISO TC 117:
ISO 12759 Fans
Efficiency
Classification
(12759-1, -2, -3, -4, -5, -6)

IEC TC 2 Chair:
• Martin Doppelbauer
WG 31:
• project leader Calc. Sheet:
  Freddy Gyllensten

Annex (informative)
Calculation sheet for losses and efficiency interpolation

- Motor alone
- VFD
- Motor + VFD
- 0.12 kW - 1000 kW
- 50 Hz / 60 Hz
- 2-, 4-, 6-, 8-poles
- Motors IE1 … IE4
- VFD IE1 … IE3
- 0% …. 100% rated power

Interpolation
Motor DOL Motor or VSD VFD
System performance calculation

Source: DTI 2015
Thank you, questions?

C O N T A C T

Conrad U. Brunner
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Member ISO TC 115 Pumps and ISO TC 117 Fans
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